137413

TREATABILITY STUDY
C & R BATTERY SITE
CHESTERFIELD COUNTY, VIRGINIA

Prepared for
U.S. Department of the Army
Corps of Engineers, Omaha District
Omaha, Nebraska
May 10, 1991

Woodward-Clyde

10842 Old Mill Road, Suite 2
Omaha, NE 68154

WCC Project No. 89M114K1

AR000255

TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDIXES

1.0
TEST PITS

Additional test pits will be excavated with a backhoe to obtain sample material for treatability studies and for defining the location of the former acid ponds. Descriptions of test pit excavation for the different tasks is as follows:

1.1 TASK 1 - TREATABILITY STUDY SAMPLES

Three test pits will be excavated at the site to obtain material for the treatability study. These test pits will be located next to Test Pits 4, 5, and 6, which were excavated during March, 1991. These locations have been selected because these sites showed the highest levels of lead contamination from samples of composited soil which were analyzed during the previous study. General procedures for test pit excavation will follow those given in Section 5.3.4.2 of the Work Plan. Additional procedures for excavation of the test pits are as follows:

- These test pits will be excavated to a depth where lead contamination is equal to or below the level of 1,000 mg/kg, based on information obtained from the RI/FS.

- Excavated material will be placed on plastic sheeting on the of the test pit. All material from the upper disturbed material will be placed on one side of the trench and all material from the lower, undisturbed, native soil horizon will be placed on the other side of the trench to keep these materials separate.

Material to be composited will be selected so that equal proportions of material from each depth interval are obtained. This material will be weighed and sieved, homogenized, and sampled according to Sections 5.3.4.4, 5.3.4.5, and 5.3.4.6 of the Work Plan, with the exception that the analytical sample will be rush analyzed for total lead only (Table 1-1).

The composited soil from each test pit will be temporarily stored on site in 5-gallon, plastic-lined buckets (or 55-gallon, plastic-lined drums) until the rush lead analysis results have been obtained. The test pit soils showing the highest total lead will be sent off to five vendors for treatability testing.

Additionally, soil samples will be taken from the test pit wall for chemical and geotechnical analysis; the number of samples are shown in Table 1-2. Procedures for this are described in Section 2.3.2.1 of SOP No. 1 for soil sampling.

The test pits will be backfilled in the same order as the material was removed. The test pit location will be staked with a 2-inch by 2-inch wooden stake placed into the center of the test pit. The test pit location will be surveyed.

1.2 TASK 4 - ACID POND TEST PITS

Based on information obtained from the exploratory borings drilled for Task 2, aerial photo evidence, EPA information, and previous study information, two additional test pits will be excavated to help define the location of the acid ponds. General procedures for test pit excavation will follow those given in Section 5.3.4.2 of the Work Plan. Additional procedures for excavation of the test pits are as follows:

- Each test pit will be dug to a depth of 5 feet or 1 foot below the reported depth of lead concentrations above 1,000 mg/kg, whichever is shallowest. If the depth of suspected contamination exceeds 5 feet, the test pit will first be dug to 5 feet to allow for sampling by personnel entering the trench.

- Excavated material will be placed on plastic sheeting to facilitate proper backfilling as discussed in the Task 1 procedures.

- Soil samples will be taken from the trench wall as described in Section 2.3.2.2 of SOP No. 1. The number of samples and analyses are shown in Table 1-3.

The test pits will be backfilled and marked as discussed in the Task 1 procedures.

TABLE 1-1
PROJECTED SOIL SAMPLE BREAKDOWN
COMPOSITED SOIL SAMPLES

Method	Parameter	No. of Field Samples	QC	Total WCC Samples	QA
6010	Total lead	3	-	-	-

TABLE 1-2
PROJECTED SOIL SAMPLE BREAKDOWN
TREATABILITY TEST PIT NATIVE SOIL SAMPLES

Method	Parameter	No. of Field Samples	QC	Total WCC Samples	QA
Chemical Samples					
6010[1]	Total lead	6	1	7	1
6010[2]	TCLP lead	6	1	7	1
Geotechnical Samples					
D422-63	Grain size	6	-	-	-
-	X-ray diffraction	6	-	-	-

(1) Rush analysis
(2) To be analyzed only on samples showing total lead greater than 1,000 mg/kg

TABLE 1-3
PROJECTED SOIL SAMPLE BREAKDOWN
ACID POND TEST PIT NATIVE SOIL SAMPLES

Method	Parameter	No. of Field Samples	QC	Total WCC Samples	QA
Chemical Samples					
6010	Total lead	4	1	5	1
6010(1)	TCLP lead	4	1	5	1
Geotechnical Samples					
D422-63	Grain size	4	-	-	-
-	Atterberg limits	4	-	-	-

(1) To be analyzed only on samples showing total lead greater than 1,000 mg/kg

In addition to test pit excavation, soil borings will be drilled and soil samples taken to define the location of the acid ponds, define the extent of off-site contamination on Capitol Oil Co. property, and obtain analytical and geotechnical samples.

2.1 TASK 2 - ACID POND EXPLORATORY BORINGS

Exploratory borings with a cumulative depth of 75 feet will be drilled in the area of the former acid ponds to define their location and extent. These borings will also be used to locate additional test pits for Task 4 (Section 1.2) and to place additional borings for Task 3 (Section 2.2). No chemical or geotechnical samples will be collected from these borings. Procedures for drilling the borings can be found in Section 2.3.1.1 of SOP No. 1.

2.2 TASK 3 - ACID POND ADDITIONAL BORINGS

A total of three additional borings will be drilled in the acid pond area based on information obtained from the Task 2 borings (Section 2.1). These borings will be used to obtain analytical and geotechnical samples from the acid pond area (Table 2-1). Procedures for drilling the borings are presented in Section 2.3.1.2 of SOP No. 1.

2.3 TASK 5 - GEOTECHNICAL SOIL BORINGS

Three soil borings will be drilled immediately adjacent to the test pit locations outlined in Task 1. The purpose of these borings is to obtain an undisturbed Shelby tube sample from the undisturbed native soil material at these sites for permeability testing, grain size analysis (Table 2-1), Atterberg limits, moisture content, and unconfined compressive strength. Procedures for drilling and sampling can be found in Section 2.3.1.3 of SOP No. 1.

2.4 TASK 7 - CAPITOL OIL SOIL BORINGS

A total of eight shallow soil borings will be drilled on the Capitol Oil Co. property to define the extent of surface and shallow subsurface contamination there. Samples will be analyzed for total lead (Table 2-1). Procedures for drilling of the soil borings and soil sampling are found in Section 2.3.1.4 of SOP No. 1.

TABLE 2-1
PROJECTED SOIL SAMPLE BREAKDOWN
SOIL BORING SAMPLES

Method	Parameter	No. of Field Samples	QC	Total WCC Samples	QA
TASK 3 - Acid Pond Borings:					
Chemical Samples					
6010	Total lead	9	1	10	1
6010[(1)]	TCLP lead	6	1	7	1
Geotechnical Samples					
SW9100	Permeability	3	-	-	-
D422-63	Grain size	3	-	-	-
D4318-84	Atterberg limits	3	-	-	-
D2216	Moisture content	3	-	-	-
D1633-84	Unconfined compressive strength	3	-	-	-
D2488-84	Classification	3	-	-	-
TASK 5 - Geotechnical Borings:					
SW9100	Permeability	3	-	-	-
D422-63	Grain size	3	-	-	-
D4318-84	Atterberg limits	3	-	-	-
D2216	Moisture content	3	-	-	-
D1633-84	Unconfined compressive strength	3	-	-	-
TASK 7 - Capitol Oil Borings:					
6010	Total lead	16	1	17	1

(1) The two samples with total lead greater than 1,000 mg/kg will be tested for TCLP lead.

3.0
DECONTAMINATION WATER SAMPLING

After the backhoe has completed digging and backfilling of all test pits, it shall be decontaminated with a pressure washer before leaving the site. A sample of decontamination water will be collected and analyzed for dissolved lead by Method 6010 (Table 3-1). The decontamination water will be sampled as described in Section 5.3.4.7 of the Work Plan.

TABLE 3-1
PROJECTED SOIL SAMPLE BREAKDOWN
DECONTAMINATION WASH SAMPLES

Method	Parameter	No. of Field Samples	QC	Total WCC Samples	QA
6010	Total lead (dissolved)(1)	1	-	-	-

(1) Samples will be filtered in the field with filter paper, preserved with HNO_3 to pH < 2, and shipped

APPENDIX A

STANDARD OPERATING PROCEDURE (SOP) NO. 1

STANDARD OPERATING PROCEDURE NUMBER 1

SOIL SAMPLING

Woodward-Clyde Consultants

Omaha, Nebraska

Project No. 89M114K1

Approvals:	Date:
______________________ Originator	______________
______________________ Peer Reviewer	______________
______________________ QA/QC Officer	______________
______________________ Project Manager	______________

Disclaimer: This Standard Operating Procedure has been prepared for the sole use of Woodward-Clyde Consultants and may not be specifically applicable to the activities of other organizations.

TABLE OF CONTENTS

LIST OF FIGURES

1.0
PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) gives descriptions of equipment, field procedures, and QA/QC procedures necessary to complete test pits, soil borings, and collect soil samples at C & R Battery.

Reference Standards

Wherever an ASTM designation is cited in the SOPs, it shall mean the American Society for Testing and Materials Standard Specification of that designation appearing in the "1990 Annual Book of ASTM Standards," published by the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania. "EM 1110-2-1906" refers to United States Department of the Army, "Engineering and Design, Laboratory Soil Testing," 30 December 1970.

2.0
PROCEDURES FOR SOIL SAMPLING

2.1 EQUIPMENT LIST

Borings into fill and clay will be drilled using hollow-stem augers (HSA). The HSA will be fitted with a center plug (if necessary) when advancing augers between split-barrel samples. All drilling will be subcontracted.

Subsurface soil samples from borings will be collected using hand utensils; a 3-inch-diameter, stainless-steel, split-spoon sampler; and 3-inch diameter Shelby tubes. No surface soil samples will be collected at this site.

Test pits will be excavated by use of a subcontracted backhoe.

The following list of equipment will be needed to collect soil samples at C & R Battery:

<u>Subsurface Soil Sampling Equipment</u>

- Drill rig with appropriate drilling and sampling tools
- Measuring tape - 100 feet
- Surveyor's stakes
- Surveyor's flags
- Field books/field sheets
- Stainless steel knife
- Laboratory-cleaned sample bottles
- Sample bottle labels
- Label tape (clear)
- Paper towels
- Camera and film
- 5-gallon plastic buckets
- 4 sieves with mesh openings of 2 inches, 1 inch, 1/2 inch, and 1/4 inch
- Stainless steel bowl
- Waterproof and permanent marking pens

- Plastic sheeting
- Plastic bags
- Appropriate health and safety equipment, as specified in the HSP
- Stainless steel trough

2.2 DECONTAMINATION

Before drilling or sampling begins, the drilling and sampling equipment will be decontaminated with a high-pressure washer or with an Alconox soap wash, a potable water rinse, and a distilled water rinse. Drilling and sampling equipment will be decontaminated between boring and sampling locations. Sampling equipment will also be decontaminated between collection of samples from different depths at the same location.

2.3 SOIL SAMPLING PROCEDURES

2.3.1 Soil Sampling for Borings

Subsurface soil sampling will begin by auger drilling a boring, using flight augers or machine-driven hollow-stem flight augers (HSA) with a 4-1/4-inch minimum inside diameter to accommodate a split-spoon sampler or a Shelby tube. Auger borings will be performed in accordance with ASTM D 1452. An HSA finger plug installed in the bit will be used to prevent soil material from entering the interior of the hollow-stem augers.

The procedure for collecting, labeling, storing, and transporting subsurface soil samples is described below:

- Record the boring location on a site map and in the field logbook.

- Decontaminate the drilling and sampling equipment according to Section 2.2.

- Select the appropriate sampler (split-spoon or Shelby tube) and collect the soil samples using the drilling rig at the intervals stated in the Work Plan (WP).

- Open the split-spoon sampler and measure the recovery and scrape off any soil smear zone from the recovered sample with a stainless steel knife.

- Determine and identify the use of the recovered sample. This will always be for soil classification and stratigraphic logging and may be for chemical analysis or geotechnical analysis.

- If lead analysis of the sample is or may be required (based on WP protocol or visual observations indicating potential contamination), the individual bottles will be filled:

The required analyses are stated in the WP. The number of additional samples retained for chemical analysis that will be submitted to the analytical laboratory will be a field decision made by the sampling team and the field manager.

- Complete the lithologic description of the recovered sample according to the Unified Soil Classification System.

- Label, store, transport, and document the samples (depending on the use of the sample).

All borings will be abandoned with a cement/bentonite mixture. Specific procedures for borings and sampling for each study task are given below.

2.3.1.1 Task 2 - Exploratory Borings

Borings will be drilled to define the extent and location of the acid ponds. The cumulative total depth of the borings will be 75 feet. No individual boring is expected to have a depth greater than 15 feet. The borings will be located based on aerial photos, EPA information, and previous study information. The procedures for drilling the borings are as follows:

- Drill boring to a depth of at least 2 feet into the native soil.
- No sampling will be conducted; however, a lithologic log will be maintained by the WCC field geologist.
- Grout the boring with cement/bentonite grout to the surface and place a marker stake at the location.

No decontamination will be required for these borings as no sampling will be conducted.

2.3.1.2 Task 3 - Acid Pond Soil Borings

Three borings will be drilled at the acid ponds to obtain samples for chemical and geotechnical analysis. The boring locations will be based on information from the exploratory borings or from aerial photo information. The procedures for drilling the borings is as follows:

- Use decontaminated hollow-stem augers.
- The soil will be sampled continuously using 3-inch, stainless-steel split spoons for lithologic logging.
- Chemical and geotechnical samples will be obtained from the 3- to 5-foot and 7- to 9-foot depth intervals.
- The boring shall be extended 2 feet below the occurrence of native soil. A Shelby tube will be pushed into the native soil for a distance of 2 feet.
- The ends of the Shelby tube will be sealed with wax to prevent drying and the Shelby tubes will be packed well for shipping.

- The borings will be grouted to the surface with cement/bentonite grout and a marker stake will be placed at the location.

2.3.1.3 Task 5 - Geotechnical Borings

Three borings will be drilled adjacent to the treatability test pits dug for Task 1. Procedures for boring and sampling are as follows:

- Use decontaminated hollow-stem augers.
- The boring will be advanced to a depth of 3 feet.
- A Shelby tube will be pushed into the native soil for a distance of 2 feet.
- The ends of the tube will be sealed with wax to prevent drying and the borings will be grouted to the surface with cement/bentonite grout. A marker stake will be placed at the location.

The samples will be packed to prevent damage and shipped to the lab.

2.3.1.4 Task 7 - Capitol Oil Borings

A total of 8 shallow borings will be drilled to a depth of 3 feet on the Capitol Oil property to further define the extent of lead contamination. Drilling will not take place until access to the property has been granted and utilities have been located. Procedures for drilling the borings are as follows:

- Use decontaminated hollow-stem augers.
- The borings will be sampled continuously with 3-inch, stainless steel split spoons.
- Analytical samples will be collected from the surface to 2 feet and from 3 to 5 feet.

- The borings will be grouted to the surface with cement/bentonite grout and a marker stake will be placed at the location.

The soil samples will be sent to the laboratory for appropriate chemical analysis.

2.3.2 Soil Sampling for Test Pits

2.3.2.1 Treatability Test Pit Soil Samples

Soil samples will be taken from the test pit wall for total lead, grain size analysis, and X-ray diffraction analysis for clay mineralogy determination. Samples showing lead levels greater than 1,000 mg/kg will also be analyzed for TCLP lead.

Procedures for soil sampling from the test pits are as follows:

- The test pit will be excavated to a maximum depth of 5 feet (the legal limit for personnel entering excavations).

- Samples will be collected by entering the test pit and removing the smear material at the levels. Samples will then be collected by use of a decontaminated stainless steel trough and a stainless steel bowl by scraping the soil material from the depth zone along the entire width of the test pit.

- Samples will be collected at several locations on the same horizon in the test pit and placed into the stainless steel bowl and mixed. Samples will be collected at the following depth intervals:

  - One sample shall be taken in the material in a zone just below the bottom of the disturbed upper soil/rubble (approximately 6 inches below contact).

  - The final sample will be collected from the lowest interval where contamination is greater than or equal to the cleanup level of

1,000 mg/kg. This sample shall be collected from the backhoe bucket if the sample comes from below 5 feet.

- The soil samples will be submitted to the laboratory for appropriate chemical analysis.

2.3.2.2 Acid Pond Test Pit Samples

A total of two additional test pits will be excavated in the acid pond area as defined by the Task 2 and Task 3 borings. Analytical and geotechnical samples will be collected from the test pits. Samples will be tested for total lead and TCLP lead, and also for grain size and Atterberg limits.

Procedures for excavating and sampling the test pits are the same as discussed in Section 2.3.2.1, with the following exceptions:

- The test pits will be excavated to a depth of 5 feet of 1 foot below the reported depth of lead above 1,000 mg/kg, whichever occurs first.

- If the depth of suspected contamination exceeds 5 feet, the test pit will be dug to 5 feet first to allow sampling below the fill/native soil contact as discussed in Section 2.3.2.1.

- If samples need to be collected below 5 feet, a stainless-steel hand auger with extensions will be used to obtain soil from the test pit wall.

- Depth intervals to be sampled are:

    - 6 inches below the fill/native soil contact
    - 1 foot below the first sample
    - The lowest interval where lead levels exceed 1,000 mg/kg

After mixing in the decontaminated stainless steel bowl, the samples will be placed in sample bottles and sent via overnight delivery to the laboratory.

2.4 FIELD QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

Field Quality Assurance/Quality Control (QA/QC) samples are designed to help identify and minimize potential sources of sample contamination due to field procedures and to evaluate potential error introduced by sample collection and handling. All field QA/QC samples are labeled with QA/QC identification numbers and sent to the laboratory with the other samples for analyses. The frequency of QA/QC samples are specified in the WP.

Field Blanks

Field blanks check for contamination of samples due to factors at the sampling site. For a field blank, appropriate containers are brought to the sampling site and filled with deionized water at the time of the soil sampling event. The sample will be assigned a QA/QC identification number, stored in an iced cooler, and shipped to the laboratory with the other samples. Field blanks will be collected according to the WP.

Rinsate Samples

An equipment rinsate sample of sampling equipment is intended to check if decontamination procedures have been effective. For the well sampling operation, a rinsate sample will be collected from the decontaminated sampling equipment before it is used to obtain the sample. Deionized water will be rinsed over the decontaminated sampling apparatus and transferred to the sample bottles. The same parameters that are being analyzed in the groundwater samples will be analyzed in the rinsate samples. The rinsate sample is assigned a QA/QC sample identification number, stored in an iced cooler, and shipped to the laboratory on the day it is collected.

Duplicate Samples

Duplicate samples are samples collected as close as possible to each other in time and space to check for the natural sample variance and the consistency of field techniques and laboratory analysis. The duplicate samples will be collected at the same time as the initial samples, and all initial samples will be duplicated. The initial (primary) sample bottles for the total metals and cyanide analyses will be filled first, then the duplicate sample bottles for total metals and cyanide, and so on until all necessary sample bottles for both the primary sample and the duplicate sample have been filled. The duplicate sample will be handled in the same manner as the primary sample. The duplicate sample will be assigned a QA/QC identification number, stored in an iced cooler, and shipped to the laboratory on the day it is collected.

<u>Matrix Spikes and Matrix Spike Duplicates</u>

Matrix spikes are used to determine the long-term precision and accuracy of the laboratory analytical method on various matrices. For this procedure duplicate samples are collected with the field samples and spiking is done by the lab. Samples are labeled as matrix spikes for the lab. It is useful to collect enough additional samples for both the matrix spike and duplicate samples from the same location.

2.5 SAMPLE IDENTIFICATION, HANDLING, AND DOCUMENTATION

Samples will be identified, handled and recorded as described in this SOP. The parameters for analysis and preservation are specified in the WP.

2.6 DOCUMENTATION

Each field activity must be properly documented to facilitate a timely and accurate reconstruction of events in the field. Sample collection field sheets will be completed for all soil samples (Figure 1).

2.6.1 Field Logbook

The most important aspect of documentation is thorough, organized, and accurate record keeping. All information pertinent to the investigation and not documented on the boring log will be recorded in a bound logbook with consecutively numbered pages. All entries in logbooks will be made in waterproof ink and corrections will consist of line-out deletions that are initialed and dated. Entries in the logbook will include the following, as applicable:

- Project name and number
- Drilling company name
- Date drilling started and finished
- Type of bit and size
- Type of drill rig
- Boring number
- Sampler's name
- Date and time of sample collection
- Sample number
- Surface elevation (if available)
- Sample depths
- Sampling method
- Observations at the sampling site
- Unusual conditions
- Information concerning drilling decisions
- Sample characteristics with depth, such as lithology, grain size, sorting, texture, structure, bedding, color, moisture content, and the Unified Soil Classification (if in unconsolidated geologic materials).
- Decontamination observations
- Weather conditions
- Names and addresses of field contacts
- Names and responsibilities of field crew members
- Names and titles of any site visitors
- Location, description, and log of photographs (if taken)
- References for all maps and photographs
- Information concerning sampling changes, scheduling modifications, and change orders
- Casing sizes and depths, if a monitoring well boring
- Well completion details, if a monitoring well boring
- Summary of daily tasks (including costs) and documentation on any cost or scope of work changes required by field conditions
- Signature and date by personnel responsible for observations

Field investigation situations vary widely. No general rules can include each type of information that must be entered in a logbook for a particular site. A site-specific logging procedure will be developed to include sufficient information so that the sampling activity can be reconstructed without relying on the memory of field personnel. The logbooks will be kept in the field team member's possession or in a secure place during the investigation. Following the investigation, the logbooks will become a part of the final project file.

2.6.2 Boring Logs

Boring logs will be completed for each boring by a WCC geologist. The boring log form, shown on Figure 2, will include the following information:

- Boring location
- Boring identification
- Drilling company
- Drilling equipment and method
- Date started and completed
- Completion depth
- Logger
- Description of lithologies by depth including soil or rock type, moisture content, color and Unified Soil Classification
- Blow counts (if appropriate)
- Samples collected, intervals and types
- Recovery (if coring)
- Other remarks or observations

SAMPLE COLLECTION FIELD SHEET

SITE NAME______________________ PROJECT NO.__________

SAMPLE NO.______________________ WELL NO.__________

DATE/TIME COLLECTED______________________ PERSONNEL__________

SAMPLE METHOD AND DEPTH______________________ __________

SAMPLE MEDIA (Circle 1): Soil Sludge Groundwater Surface Water

SAMPLE SPLIT (Circle 1) Yes No SPLIT SAMPLE NO.__________

Sample Container	Preservative	Analysis Requested

WELL PURGING

Date______________________ Well Depth (TOC)__________
HNu/OVA Measurements:__________ Depth to Water (TOC)__________
Background__________ Water Column Length__________
Wellhead__________ 2" Casing__________ x 0.16 gal/ft
Breathing Zone__________ Volume of Water in Well__________
Time Started__________ Casing Volumes to Purge__________
Time Completed Minimum Water to Purge

FIELD MEASUREMENTS

Time	Amount Purged (gal)	pH	Temp. (°C)	Conductivity (umhos/cm)	Color	Odor	Turbidity

FIELD EQUIPMENT AND CALIBRATION

	Instrument Model	Calibration
Water Level Indicator		
Conductivity Meter		
pH Meter		Before__________ After__________

Comments____

Figure No. 1

AR000284

WOODWARD-CLYDE CONSULTANTS

BORING LOG

PROJECT NAME ______________________________ SHEET ___ OF ___

LOCATION ______________ PROJECT NO. ______________

LOGGED BY ______________ DRILLED BY ______________

RIG/METHOD ______________ DATE ______________

BORING

SURFACE ELEVATION ______________ ELEVATION DATUM ______________

WATER ENTRY DEPTH ______ FEET ATD WATER SURFACE DEPTH ______ FEET ______ AD

DEPTH	TYPE	SAMPLE REC	SAMPLE RES	DESCRIPTION	USC	SPECIAL NOTES & OBSERVATIONS

AR000285

WOODWARD-CLYDE CONSULTANTS FIGURE NO. 2

APPENDIX B

STANDARD PRACTICE FOR THIN-WALLED TUBE SAMPLING OF SOILS

Designation: D 1587 – 83

Standard Practice for Thin-Walled Tube Sampling of Soils[1]

This standard is issued under the fixed designation D 1587; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This practice has been approved for use by agencies of the Department of Defense and for listing in the DOD Index of Specifications and Standards.

1. Scope

1.1 This practice covers a procedure for using a thin-walled metal tube to recover relatively undisturbed soil samples suitable for laboratory tests of structural properties. Thin-walled tubes used in piston, plug, or rotary-type samplers, such as the Denison or Pitcher, must comply with the portions of this practice which describe the thin-walled tubes (5.3).

NOTE 1—This practice does not apply to liners used within the above samplers.

2. Referenced Documents

2.1 *ASTM Standards:*

D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)[2]

D 3550 Practice for Ring-Lined Barrel Sampling of Soils[2]

D 4220 Practices for Preserving and Transporting Soil Samples[2]

3. Summary of Practice

3.1 A relatively undisturbed sample is obtained by pressing a thin-walled metal tube into the in-situ soil, removing the soil-filled tube, and sealing the ends to prevent the soil from being disturbed or losing moisture.

4. Significance and Use

4.1 This practice, or Practice D 3550, is used when it is necessary to obtain a relatively undisturbed specimen suitable for laboratory tests of structural properties or other tests that might be influenced by soil disturbance.

5. Apparatus

5.1 *Drilling Equipment*—Any drilling equipment may be used that provides a reasonably clean hole; that does not disturb the soil to be sampled; and that does not hinder the penetration of the thin-walled sampler. Open borehole diameter and the inside diameter of driven casing or hollow stem auger shall not exceed 3.5 times the outside diameter of the thin-walled tube.

5.2 *Sampler Insertion Equipment,* shall be adequate to provide a relatively rapid continuous penetration force. For hard formations it may be necessary, although not recommended, to drive the thin-walled tube sampler.

5.3 *Thin-Walled Tubes,* should be manufactured as shown in Fig. 1. They should have an outside diameter of 2 to 5 in. and be made of metal having adequate strength for use in the soil and formation intended. Tubes shall be clean and free of all surface irregularities including projecting weld seams.

5.3.1 *Length of Tubes*—See Table 1 and 6.4.

5.3.2 *Tolerances,* shall be within the limits shown in Table 2.

5.3.3 *Inside Clearance Ratio,* should be 1 % or as specified by the engineer or geologist for the soil and formation to be sampled. Generally, the inside clearance ratio used should increase with the increase in plasticity of the soil being sampled. See Fig. 1 for definition of inside clearance ratio.

5.3.4 *Corrosion Protection*—Corrosion, whether from galvanic or chemical reaction, can damage or destroy both the thin-walled tube and the sample. Severity of damage is a function of time as well as interaction between the sample and the tube. Thin-walled tubes should have some form of protective coating. Tubes which will contain samples for more than 72 h shall be coated. The type of coating to be used may vary depending upon the material to be sampled. Coatings may include a light coat of lubricating oil, lacquer, epoxy, Teflon, and others. Type of coating must be specified by the engineer or geologist if storage will exceed 72 h. Plating of the tubes or alternate base metals may be specified by the engineer or geologist.

5.4 *Sampler Head,* serves to couple the thin-walled tube to the insertion equipment and, together with the thin-walled tube, comprises the thin-walled tube sampler. The sampler head shall contain a suitable check valve and a venting area to the outside equal to or greater than the area through the check valve. Attachment of the head to the tube shall be concentric and coaxial to assure uniform application of force to the tube by the sampler insertion equipment.

6. Procedure

6.1 Clean out the borehole to sampling elevation using whatever method is preferred that will ensure the material to be sampled is not disturbed. If groundwater is encountered, maintain the liquid level in the borehole at or above ground water level during the sampling operation.

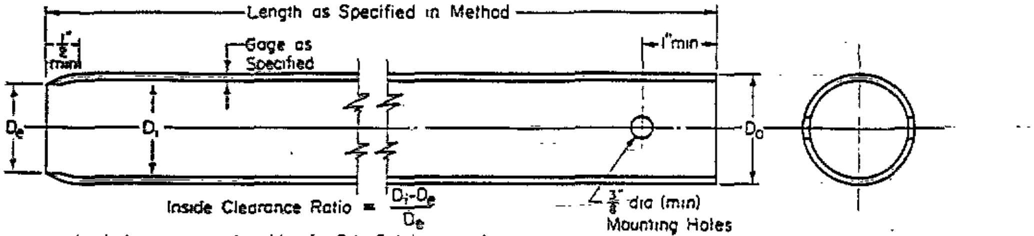
6.2 Bottom discharge bits are not permitted. Side discharge bits may be used, with caution. Jetting through an open-tube sampler to clean out the borehole to sampling elevation is not permitted. Remove loose material from the center of a casing or hollow stem auger as carefully as

[1] This practice is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigations.

Current edition approved Aug. 17, 1983. Published October 1983. Originally published as D 1587 – 58 T. Last previous edition D 1587 – 74.

[2] *Annual Book of ASTM Standards,* Vol 04.08.

AR000287



NOTE 1—Minimum of two mounting holes on opposite sides for 2 to 3½ in. sampler.
NOTE 2—Minimum of four mounting holes spaced at 90° for samplers 4 in. and larger.
NOTE 3—Tube held with hardened screws.
NOTE 4—Two-inch outside-diameter tubes are specified with an 18-gage wall thickness to comply with area ratio criteria accepted for "undisturbed samples." Users are advised that such tubing is difficult to locate and can be extremely expensive in small quantities. Sixteen-gage tubes are generally readily available.

Metric Equivalents

in.	mm
3/8	6.77
½	12.7
1	25.4
2	50.8
3½	88.9
4	101.6

FIG. 1 Thin-Walled Tube for Sampling

TABLE 1 Suitable Thin-Walled Steel Sample Tubes[A]

Outside diameter:			
in.	2	3	5
mm	50.8	76.2	127
Wall thickness:			
Bwg	18	16	11
in.	0.049	0.065	0.120
mm	1.24	1.65	3.05
Tube length:			
in.	36	36	54
m	0.91	0.91	1.45
Clearance ratio, %	1	1	1

[A] The three diameters recommended in Table 1 are indicated for purposes of standardization, and are not intended to indicate that sampling tubes of intermediate or larger diameters are not acceptable. Lengths of tubes shown are illustrative. Proper lengths to be determined as suited to field conditions.

TABLE 2 Dimensional Tolerances for Thin-Walled Tubes

Nominal Tube Diameters from Table 1[A] Tolerances, in.			
Size Outside Diameter	2	3	5
Outside diameter	+0.007	+0.010	+0.015
	−0.000	−0.000	−0.000
Inside diameter	+0.000	+0.000	+0.000
	−0.007	−0.010	−0.015
Wall thickness	±0.007	±0.010	±0.015
Ovality	0.015	0.020	0.030
Straightness	0.030/ft	0.030/ft	0.030/ft

[A] Intermediate or larger diameters should be proportional. Tolerances shown are essentially standard commercial manufacturing tolerances for seamless steel mechanical tubing. Specify only two of the first three tolerances; that is, O.D. and I.D., or O.D. and Wall, or I.D. and Wall.

possible to avoid disturbance of the material to be sampled.

NOTE 2—Roller bits are available in downward-jetting and diffused-jet configurations. Downward-jetting configuration rock bits are not acceptable. Diffuse-jet configurations are generally acceptable.

6.3 Place the sample tube so that its bottom rests on the bottom of the hole. Advance the sampler without rotation by a continuous relatively rapid motion.

6.4 Determine the length of advance by the resistance and condition of the formation, but the length shall never exceed 5 to 10 diameters of the tube in sands and 10 to 15 diameters of the tube in clays.

NOTE 3—Weight of sample, laboratory handling capabilities, transportation problems, and commercial availability of tubes will generally limit maximum practical lengths to those shown in Table 1.

6.5 When the formation is too hard for push-type insertion, the tube may be driven or Practice D 3550 may be used. Other methods, as directed by the engineer or geologist, may be used. If driving methods are used, the data regarding weight and fall of the hammer and penetration achieved must be shown in the report. Additionally, that tube must be prominently labeled a "driven sample."

6.6 In no case shall a length of advance be greater than the sample-tube length minus an allowance for the sampler head and a minimum of 3 in. for sludge-end cuttings.

NOTE 4—The tube may be rotated to shear bottom of the sample after pressing is complete.

6.7 Withdraw the sampler from the formation as carefully as possible in order to minimize disturbance of the sample.

7. Preparation for Shipment

7.1 Upon removal of the tube, measure the length of sample in the tube. Remove the disturbed material in the upper end of the tube and measure the length again. Seal the upper end of the tube. Remove at least 1 in. of material from the lower end of the tube. Use this material for soil description in accordance with Practice D 2488. Measure the overall sample length. Seal the lower end of the tube. Alternatively, after measurement, the tube may be sealed without removal of soil from the ends of the tube if so directed by the engineer or geologist.

NOTE 5—Field extrusion and packaging of extruded samples under the specific direction of a geotechnical engineer or geologist is permitted.
NOTE 6—Tubes sealed over the ends as opposed to those sealed with expanding packers should contain end padding in end voids in order to prevent drainage or movement of the sample within the tube.

7.2 Prepare and immediately affix labels or apply markings as necessary to identify the sample. Assure that the markings or labels are adequate to survive transportation and storage.

8. Report

8.1 The appropriate information is required as follows:

8.1.1 Name and location of the project,

8.1.2 Boring number and precise location on project,

8.1.3 Surface elevation or reference to a datum,

8.1.4 Date and time of boring—start and finish,

8.1.5 Depth to top of sample and number of sample,

8.1.6 Description of sampler: size, type of metal, type of coating,

8.1.7 Method of sampler insertion: push or drive,

8.1.8 Method of drilling, size of hole, casing, and drilling fluid used,

8.1.9 Depth to groundwater level: date and time measured,

8.1.10 Any possible current or tidal effect on water level,

8.1.11 Soil description in accordance with Practice D 2488,

8.1.12 Length of sampler advance, and

8.1.13 Recovery: length of sample obtained.

9. Precision and Bias

9.1 This practice does not produce numerical data; therefore, a precision and bias statement is not applicable.